Name Date

HANDS-ON LAB

Modeling Geologic Stress

Do you ever wonder how geologists can look at rock layers and know about the history of Earth's surface? Or how they can determine what Earth's surface looked like thousands or even millions of years ago? Much of Earth's history is stored in rock layers, and the patterns within those layers can tell scientists about tectonic plate movement, climate, natural disasters, and how both land and ocean regions have changed shape and position over time.

Folded rock layers form when compressive forces push a region of Earth's surface closer together, causing the deformation of rock. Folds can occur either upward or downward and can look like a gentle wave or a sharper, tighter folding pattern. Over very long time periods, the folding of rock can lead to massive mountains, such as the Himalayas and the Alps.

If the compressive forces lead to breaking, it is called a fault. Mountains made from blocks of rock broken up by faults are called fault-block mountains. The Sierra Nevada mountains are fault-block mountains. Faults can lead to formations other than mountains. For example, Death Valley was formed by a block of land dropping down between two faults.

In this lab, you will use a model to investigate how rock layers are affected by different types of physical stress. You will vary the composition and thickness of the layers in your model to compare any differences in how each one is affected by stress.

MATERIALS

- safety goggles, nonlatex apron, vinyl gloves
- camera to take still photos or video
- geologic compression box, or materials to assemble one
- granular materials, such as flour, sugar, salt, coffee grounds, dirt, cornmeal, cornstarch, or other available nontoxic substances
- paper
- pencil
- protractor
- ruler or grid
- sand
- straws

RESEARCH QUESTION How are rock layers affected by compression forces?

MAKE A CLAIM

Make an initial claim about how layers of rock will be affected as a compression force is applied in a model.

SAFETY INFORMATION

- Wear indirectly vented chemical splash goggles, a nonlatex apron, and vinyl gloves during the setup, hands-on, and takedown segments of the activity.
- Immediately clean up any granular substance on the floor so it does not become a slip/fall hazard.
- If the box is made of unfinished wood, be careful to prevent splinters on hands when setting up or taking down a trial.
- Wash your hands with soap and water immediately after completing this activity.

CONDUCT RESEARCH

1. Research convergent and divergent boundaries. Where on Earth's crust are large convergent and divergent boundaries? What types of formations are likely at the boundaries?

2. Research the process of folded-mountain formation. Where are folded mountains likely to occur? How long do they take to form?

3. Find diagrams of types of faults that can occur along tectonic plate boundaries, including strike-slip, normal, and thrust faults. Describe the plate movement that takes place at each type of fault. Consider using one of these features in the layer system you place in the geologic compression box.

PLAN THE INVESTIGATION

1. **Develop a Model** Come up with ideas for how convergence and divergence could be modeled with the geologic compression boxes. What will tilting the compression box model? Make notes in your Evidence Notebook.

2. Decide how you will vary the thickness and composition of layers. Alternate layers of light- and dark-colored materials to ensure that you can see the movement of each layer. One option is to alternate layers of sand with layers of other materials. Thin layers will allow for clearer visualization of changes with compression. You might consider including a pre-existing feature within your layers, such as slanted layers that model a previous geologic event, or a type of fault (strike-slip, normal, or thrust). Draw and label a sketch of your plan for the layers in your Evidence Notebook.

3. Plan how you will apply stress to the layer system you designed in Step 2. You will conduct three different trials using the same layer system so that you may compare how the layers change in each one. Each trial should involve the application of stress to represent convergent forces and the removal of stress to represent divergent forces. Decide how you will adjust the position (tilt) of the geologic compression box and/or increase or decrease compressional stress on the layers for each test. Keep in mind that a trial can involve a series of actions. For example, one trial could model what happens to rock layers when tectonic plates converge for a period of time but then begin to diverge due to changes in the Earth system. If your plan for a trial involves a series of actions, be prepared to observe and record the changes that occur at each stage.

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CARRY OUT THE INVESTIGATION

1. **Use a Model** Carefully pour or scoop material into the geologic compression box to form each layer for your first trial. Make sure layers are smooth and even unless you intend to begin with a formation in place. Carefully observe and record the initial conditions of the system.
2. Gently and slowly adjust the position of the geologic compression box, as well as the compressional stress acting on the layers, according to your investigation plan. Observe and sketch how each change you make to the geologic compression box affects the layers. Note the details of how layers move relative to each other and any features formed. If a camera is available, take photos or video before, during, and after the test, in addition to making the sketches.
3. Once you have finished a trial, carefully pour material out of the box into a waste bin. Dust any remaining material out of the box.
4. Repeat Steps 1–3, collecting data for at least three trials.

COLLECT DATA

Sketch the changes that you observe in the layer system for each trial in the boxes provided. Several small sketches may be drawn in each box. Label the sketches to facilitate comparison and other types of analysis.

Trial 1

Trial 2

Trial 3

Name **Date**

ANALYZE

Patterns Compare the results of each of your trials. What patterns can you identify in the response of the layers to different types of stress?

CONSTRUCT AN EXPLANATION

1. How did the initial conditions of the model system, such as composition and thickness of the layers, affect its response to compression forces and to changes in the tilt of the box?

2. How did the way force was applied to the model system affect its response? When was any folding or faulting observed?

3. **Developing and Using Models** Was a divergent boundary modeled effectively and accurately using the geologic compression box? Why or why not?

DRAW CONCLUSIONS

Write a conclusion that addresses each of the points below.

Claim How were the layers of rock affected by the compression force that you applied in your model? Was your initial claim correct?

Evidence What evidence from your models supports your claim?

Reasoning Explain how the evidence you gave supports your claim. Describe in detail the connections between the evidence you cited and the argument you are making.

EXTEND

Try using denser materials, such as moldable play sand or compressible clay, and creating very thin, dense layers with alternating colors. Observe how the layers behave in comparison to more granular layers when you tilt the compression box or change the stress applied to the layers.